Sustainable use of light for chemical and electrical energy production *

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The Earth receives around 1.9 x 10^6 EJ of energy in visible light each year but only a fraction of this sunlight energy is being converted to biomass (chemical energy) through the process of photosynthesis. There is no doubt our fossil fuel resources are depleting; therefore there is an urgent need for an alternative source of renewable energy that is sustainable. This project works on the potential of developing a novel cultivation system for maximising the use of solar energy by combining solar panels with outdoor microalgae ponds for the production of both chemical and electrical energy.

Out of all photosynthetic organisms, microalgae, due to their fast growth rates, ability to grow on seawater and use of non-arable land, have been identified as a potential source of raw material for chemical energy production. Only a fraction of the electromagnetic spectrum of sunlight in the wavelength range 400–700 nm (also known as the photosynthetic active radiation or PAR) is absorbed by chlorophyll and other accessory pigments of the algae. This spectrum of visible light covers the range from the violet-blue wavelengths over green to orange-red wavelengths.

Although most research work so far has focused on the effects of light quantity or irradiance intensity on the growth, morphology and pigmentation of microalgae, it has also been successfully identified that the colour of light also plays a vital role in vegetative development, reproductive induction and growth rate in microalgae. Therefore part of this research project that we are currently investigating is to identify the light spectrum or colour that is required by the selected microalgae strains for its growth and productivity.

Solar panels have also been used worldwide for electrical energy production but the most efficient commercially available solar cell can only convert ~17% of the solar spectrum into electricity. Certain types of solar panels absorb strongly in the green part of the solar spectrum but not as much as in the blue or the red part. On the other hand, it is interesting to note that some groups of microalgae (i.e Chlorophyta) only require the blue and red part of the light spectrum for its growth and productivity.

This has led to our current work on combining both energy production systems which would allow for a full utilisation of the solar spectrum thus enabling the production of both chemical and electrical energy from one facility making efficient use of available land and solar energy. In this research experiment, we are trying to place a modified solar panel as a filter above the algae culture to modify the spectrum of light received by the algae and utilise the unused parts of the spectrum to generate electricity. In simple terms, we would be giving the microalgae the colour of light required to grow while converting all the unused light spectrum into electricity through the use of photovoltaic devices. Furthermore, another great advantage would be that the harvested algal biomass can be used as a feedstock for production of biodiesel, feed, food and other high-value bioactive products.

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